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CLIMATE OF KANSAS.

BY PROF. FRANK H. SNOW.

STATE UNIVERSITY, LAWRENCE, KANSAS, }
January 1st, 1873. }HON. ALFRED GRAY, *Secretary State Agricultural Society* :

DEAR SIR: In compliance with your request I send you this day the following facts in regard to the climate of Kansas, embodying the results of my own observations since January 1st, 1868. The geographical position of Lawrence is such that these observations may be safely presumed to represent the average meteorological conditions of the eastern half of Kansas. The precise location of this station is as follows: Latitude $38^{\circ} 58'$; longitude $95^{\circ} 16'$; elevation of instruments 884 feet above the level of the sea. The instruments are of the highest standard quality, most of them from the manufactory of James Green, of New York City, maker of instruments for the Smithsonian Institution. In addition to the ordinary apparatus for taking what are called "first-class" observations, the University now possesses and has in successful operation a complete and highly valuable collection of self-registering instruments, by means of which the velocity of the wind, the direction of the wind, the height of the barometer column, and the rainfall, are recorded for every instant of time. This automatic apparatus cannot fail to greatly enhance the value of the meteorological work performed under the auspices of the State University. For example, the determination of the velocity of our Kansas winds will doubtless dispel many vague and exaggerated notions now prevalent concerning this peculiar feature of our climate.

The first element to be considered in our climatology is

TEMPERATURE.

The following table gives the mean temperature of each month and year over which our observations have extended:

Table I.—Mean Monthly Temperature at Lawrence, Kansas.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1868.....	23. 967	35. 071	50. 991	49. 065	66. 076	75. 905	85. 990	74. 017	62. 927	53. 906	37. 999	24. 029
1869.....	30. 50	30. 63	35. 07	49. 44	59. 87	66. 86	72. 22	73. 30	59. 93	43. 75	42. 39	36. 92
1870.....	29. 43	35. 42	37. 69	56. 84	68. 00	73. 71	80. 27	73. 54	67. 88	56. 50	44. 92	28. 70
1871.....	28. 86	35. 30	47. 42	57. 90	66. 05	76. 85	80. 28	75. 34	65. 16	56. 05	35. 89	24. 91
1872.....	24. 35	30. 44	37. 23	56. 42	65. 98	76. 98	77. 96	77. 27	66. 73	5. 64	33. 36	19. 96
Mean for five years ..	27. 36	33. 50	41. 66	54. 05	65. 45	73. 89	79. 33	75. 12	64. 41	53. 00	8. 91	26. 95

From the preceding table it will be seen that the monthly temperatures are subject to considerable variation. Thus, March and November are sometimes winter months, while May and September are occasionally summer months. The second half of May and the first half of September almost invariably belong to the summer season.

The mean temperatures of the different seasons, together with the mean annual temperature, are shown in the following table:

Table II.—Mean Temperatures of Seasons and Years at Lawrence, Kansas.

Years.	Spring.	Summer.	Autumn.	Winter.	Year.
1868.....	55. 977	78. 937	51. 014	27. 089	53. 936
1869.....	48. 15	71. 17	48. 64	32. 70	50. 36
1870.....	54. 15	75. 86	56. 43	31. 04	54. 50
1871.....	57. 32	77. 50	52. 33	29. 50	54. 30
1872.....	53. 21	77. 40	51. 91	24. 91	51. 90
Mean for five years.....	53. 72	76. 06	52. 09	29. 21	52. 88

The mean annual temperature, as given in the preceding table, does not differ essentially from that of the States to the east of Kansas in the same latitude, viz.: Missouri, Southern Illinois, Southern Indiana, Southern Ohio, Kentucky, Virginia, and Maryland.

The summers of Kansas, however, are somewhat warmer and the winters considerably colder than those of the states just mentioned, which is to be explained by the fact that the warm winds from the heated, treeless plains on the southwest, and the cold winds from the snow-clad mountains on the northwest, sweep over Kansas with little diminution of their original intensity of temperature. .

THE SUMMER SEASON.

The average number of days on which the mercury reached or exceeded ninety degrees during the five summers observed, was thirty-eight. In the cool summer of 1869 there were only twenty-three such days, while in the hot summer of 1870 there were forty-six. But though the thermometer indicates a higher temperature on a greater number of days in Kansas than in States in the same latitude on the east, there are important compensations by which the summer heat is, on the whole, as easily borne as in the eastern States. In July, 1870, for instance, though the mean temperature at 2 P. M. was nearly ninety-one degrees for the entire month, the nights were invariably cool, the mean temperatures at 7 A. M. and 9 P. M. being seventy-four and seventy-six degrees respectively. Another compensation is the constant circulation of the air, which rarely becomes calm in the summer season. Still another, and most important modifier of the heat, is the dryness of our Kansas atmosphere,

which is a general characteristic of the climate and makes the high temperature of midsummer comparatively easy to endure. The greater the amount of moisture in the air, the more oppressive becomes the heat, so that eighty degrees in Philadelphia is more intolerable than ninety degrees in Lawrence.

THE WINTER SEASON.

The winters of Kansas are generally open, the fall of snow being comparatively light, rarely exceeding six inches in depth for a single storm. The average annual depth of snow for the five years observed was $21\frac{1}{2}$ inches, the least amount being $9\frac{1}{2}$ inches in 1870, and the greatest $29\frac{3}{4}$ inches in 1871.

There is great variation in the severity of our winter months. In 1869 the mercury sank below zero on but two days, the lowest point being only five degrees below zero, while in 1872 the zero point was passed on sixteen days, the lowest point being eighteen degrees below zero, and the mercury being below zero during some portion of the twenty-four hours on eight successive days (Dec. 20th to 27th).

There is also great variation in the duration of the winter seasons. In the winter of 1867-68, farmers were plowing during the whole of December and until the fifth day of January, on which date winter properly began. Uninterrupted cold weather then continued until the twelfth of February, when the winter was at an end after an existence of 38 days. Farmers were plowing again on the fifteenth of February, and there were only five days thereafter (four in February and one in March,) on which the mean temperature fell below the freezing point. The winter of 1871-72, on the other hand, was nearly three months in length, extending from the eighteenth of November to the fifteenth of February. The Kansas river was closed at Lawrence on the twenty-seventh of November and was not opened until the twenty-third of February, a period of 88 days.

KANSAS TEMPERATURE COMPARED WITH THAT OF OTHER STATES.

As furnishing the means of comparing the mean temperatures of Kansas with those of other States, the following table is introduced, which, together with a similar table concerning the rainfall, was prepared by the writer for Mr. C. C. Hutchinson's "Resources of Kansas." These tables were compiled from the observations of the four hundred meteorological observers of the Smithsonian Institution, of whom nearly twenty are located in different parts of Eastern Kansas, including Atchison on the north, Baxter Springs on the south, Leavenworth and Olathe on the east, and Manhattan on the west. Only twenty States are represented in this comparison, those States engaged in the rebellion being omitted because the returns from them for the years 1865, '66 and '67 are too meagre to afford trustworthy results:

Table III.— Mean Temperature of Kansas in comparison with that of other States, from January first, 1865, to January first, 1870.

State.	Spring.	Summer.	Autumn.	Winter.	Year.
Kansas	52.02	75.05	54.03	29.01	52.08
Maine	40.7	66.4	46.6	19.8	43.4
New Hampshire	41.7	66.7	46.6	20.4	43.8
Vermont	40.4	66.1	45.6	18.4	42.7
Massachusetts	45.0	68.6	49.7	25.5	47.2
Connecticut	45.0	69.1	50.4	25.8	47.6
New York	43.9	69.7	50.0	24.9	47.1
New Jersey	49.8	72.3	54.3	30.3	51.7
Pennsylvania	47.3	71.7	52.0	28.1	49.7
Maryland	51.7	74.2	55.6	32.4	53.5
Kentucky	54.4	74.5	55.7	35.2	54.9
Ohio	49.4	72.6	52.7	29.1	50.9
Michigan	42.4	67.8	49.1	34.2	45.9
Indiana	50.4	74.2	53.2	29.7	51.9
Illinois	47.6	72.9	52.0	25.8	49.6
Wisconsin	41.8	68.6	47.8	20.5	44.7
Minnesota	39.4	67.8	45.3	14.0	41.6
Iowa	44.5	71.2	48.9	20.3	46.2
Missouri	52.5	75.5	55.0	30.7	53.4
Nebraska	45.9	73.4	51.0	22.9	48.4
Mean for twenty States	46.3	70.9	50.8	25.4	48.3

RANGE OF TEMPERATURE.

In estimating the influence of climate upon agriculture, it is important to know not only the mean temperature, but also the range of temperature for each month and season. The horticulturist will not wisely place his chief dependence upon a kind of fruit which is liable to be entirely cut off by the extreme cold of winter or the severe frosts of spring. The farmer will not wisely venture his all upon a crop which the intense heat of an exceptionally hot summer would certainly destroy, nor can he safely delay his harvesting beyond the time when the records show the possible occurrence of the first "killing frost" of autumn.

The following table gives the extremes of temperature for each month of the past five years :

Table IV.— Extremes of Temperature for each month at Lawrence, Kansas, from January first, 1868, to January first, 1873.

Month.	1868.		1869.		1870.		1871.		1872.		Mean monthly range.
	Maxi- mum.	Mini- mum.									
January	64.0	-7.0	58.0	6.0	56.5	-1.0	67.5	-5.0	50.5	-7.5	61.8
February	72.0	-3.0	68.0	-5.0	69.0	-4.0	71.5	-3.0	61.0	-12.0	73.9
March	93.0	22.0	81.0	-1.0	71.0	1.0	78.0	25.5	72.0	18.0	85.9
April	83.0	25.0	87.0	18.0	91.0	19.0	92.0	30.5	85.0	30.0	63.1
May	84.0	49.0	88.0	25.0	90.0	44.0	92.0	37.0	88.0	39.0	47.6
June	99.0	57.0	90.0	37.0	102.0	44.0	96.0	63.0	97.0	53.0	46.0
July	101.0	70.0	93.0	47.0	99.0	55.0	103.0	60.0	93.5	61.5	39.2
August	93.0	57.0	96.0	56.0	98.0	53.0	100.0	45.0	97.0	53.0	44.0
September	93.0	29.0	85.0	30.0	88.5	53.0	92.5	36.0	94.0	37.0	53.6
October	82.0	25.0	78.0	15.0	79.0	29.0	90.0	32.0	92.0	27.0	58.6
November	73.0	17.0	72.0	23.0	72.0	17.0	72.5	3.0	67.0	-1.0	59.5
December	53.0	-16.5	65.0	4.0	64.0	-10.0	58.0	-6.0	58.5	-18.0	69.0

LONG PERIOD OF ABSENCE OF FROST.

An important point to be noticed in considering the preceding table is the long period of absence of frost. The average date of the last light frost of spring is April 15th; that of the first light frost in autumn is September 25th, giving an average interval of 164 days entirely without frost. The period of immunity from *severe* frosts is considerably longer, averaging 194 days, from about the fifth of April to the fifteenth of October. The April frosts are not often severe enough to materially injure fruit buds. In April, 1868, the thermometer marked seven degrees below the freezing point, but the fruit crop was not damaged, though peaches, pears and plums were in full blossom at the time. In April, 1870, however, on the sixteenth, the mercury fell thirteen degrees below the freezing point and nearly all pears, plums, early apples and budded peaches were killed; while grapes, strawberries and other small fruits were almost entirely uninjured. Of all our leading fruits the peach alone is sometimes fatally affected by the extreme cold of winter, as was the case in December, 1868, and December, 1872. Under ordinary circumstances the peach bud seems incapable of surviving a greater intensity of cold than fifteen degrees below zero. From the two causes already mentioned, the occasional very severe frosts of April and the extreme cold of winter, a good crop of peaches cannot reasonably be expected in Kansas in a series of years oftener than about half the time. Thus, in 1868, 1871, and 1872, this fruit was produced in great abundance, while in 1869, 1870, and 1873 (speaking prospectively of the latter year), the supply was exceedingly deficient, and limited almost entirely to late-ripening seedlings.

The preceding remarks will serve to show the necessity of choosing the best location for an orchard and the best varieties of fruit. A northern slope is preferable to a southern, since in the former location the buds are less liable to be prematurely expanded; the upland prairie is preferable to the bottom lands because the frosts are less severe as elevation above the streams is increased; and those varieties of fruit should take precedence which are most likely to postpone the period of blossoming until after the severe frosts of early spring. The foregoing observations will serve to show that so far as temperature is concerned the climate of Kansas is naturally adapted to the successful production of the great staples of agriculture peculiar to the middle latitudes of the United States. Indeed the long period of freedom from frost, and the prolonged heat of the summer season would seem at least to invite experiment in the culture of crops generally considered to belong to a more southerly latitude.

The second element which demands attention in estimating the climate of Kansas is the

RAINFALL.

The annexed table indicates the amount of rain in inches, including melted snow, for each month of the period under discussion :

Table V.—Rainfall in inches for each month, at Lawrence, Kansas, from January first, 1868, to January first, 1873.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1868	0.36	0.19	3.46	2.95	2.81	3.80	4.05	8.32	4.29	1.58	3.54	2.13
1869	2.90	1.44	1.15	2.43	3.64	7.57	5.05	6.46	4.45	0.69	1.86	0.87
1870	0.67	0.03	1.86	1.08	2.46	1.88	5.58	6.69	2.82	6.96	0.57	0.72
1871	1.11	2.43	1.73	2.38	2.79	4.06	7.30	2.76	1.49	3.58	2.48	1.12
1872	0.17	0.82	2.92	4.74	5.72	1.30	6.50	4.71	2.55	1.95	0.01	1.24
Mean..	1.04	0.98	2.22	2.72	3.48	3.72	5.70	5.79	3.12	2.95	1.69	1 22

The above table shows the peculiar distribution of rain through the different months of the year. Beginning with February, in which the average precipitation is reduced to its minimum, there is a constant increase in each month until July and August, when the rainfall reaches its maximum and begins to decline, each succeeding month showing a decrease in the average amount until the minimum is again reached in February. And while this regularity is seen to exist in the *average* monthly supplies of rain, it will be observed that in no single month of the growing season in either of the five years was the rainfall so light as to interfere in any considerable degree with the proper growth and ripening of the staple productions of the farmer. The comparative amounts of rain for the different seasons and the annual amounts are exhibited in an additional table:

Table VI.—Mean Precipitation of Rain for Seasons and Years at Lawrence, Kansas.

Years.	Spring.	Summer.	Autumn.	Winter.	Year.
1868.....	9.22 in.	16.17 in.	9.41 in.	2.68 in.	37.48 in.
1869.....	7.22	19.08	7.00	5.21	38.51
1870.....	5.40	14.15	10.35	1.44	31.32
1871.....	6.90	14.12	7.55	4.66	33.23
1872.....	13.38	12.51	4.51	2.26	32.63
Mean	8.42	15.21	7.76	3.24	34.63

A remarkable feature in the rainfall of Kansas is made evident by the preceding table, from which it appears that only about one-tenth of the annual precipitation occurs in the winter months. In the eastern States the amount of rain, including melted snow, is nearly as large in winter as in each of the other seasons. In Kan-

sas, which has less rain in winter than any State in the Union except Minnesota and Nebraska, the apparent deficiency is abundantly made good by a more copious supply of rain in spring, summer and autumn than is received by the great majority of the other States. In confirmation of this statement, and for a more extended comparison, the following table is introduced, based, like table III, upon the observations of the observers of the Smithsonian Institution, and representing the rainfall in nearly twenty different localities in eastern Kansas. It appears from the table that during the five years from January 1st, 1865, to January 1st, 1870, the average annual rainfall for Kansas was greater than that of the following states: New Hampshire, Vermont, Ohio, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri and Nebraska, (10 States out of the 19); also that the average amount of rain for the spring, summer and autumn months was greater in Kansas than in any of the other States except Connecticut, Maryland, New Jersey and Kentucky; and finally that for the seven months from the first of March to the first of October, when rain is needed for the germination and growth of crops, Kansas stands at the head of the list, having more rain than any of the nineteen States with which the comparison was made. It will be observed that the quantities for Kansas are greater in this table than in tables V and VI, based upon the observations of the writer. This may be accounted for by remembering that the periods of observation are not the same, and that certain other places in Kansas, especially in the southern portion, have undoubtedly a greater rainfall than Lawrence:

Table VII.—Rainfall of Kansas compared with that of other States, from Jan. 1, 1865, to Jan. 1, 1870

States.	Spring.	Summer.	Autumn.	Winter.	March 1st to Oct. 1st	Year.
Kansas	10.82	18.06	9.79	5.42	34.15	44.09
Maine	13.74	10.55	13.33	9.99	28.23	47.61
New Hampshire	10.40	10.49	12.66	7.85	25.40	41.40
Vermont	10.31	10.44	11.82	7.32	25.01	39.89
Massachusetts	13.46	11.17	11.72	10.20	28.71	46.55
Connecticut	13.01	13.34	13.11	10.54	30.88	50.00
New York	11.16	11.19	12.41	9.92	26.85	44.68
New Jersey	13.18	13.88	12.53	11.39	31.81	50.98
Pennsylvania	12.04	12.46	11.17	10.01	29.05	45.68
Maryland	13.67	13.95	12.39	11.22	32.05	51.23
Kentucky	15.18	13.77	9.88	12.50	33.92	51.33
Ohio	12.34	11.73	9.80	8.09	29.24	41.98
Michigan	8.32	9.90	11.00	6.47	23.19	35.69
Indiana	14.35	12.84	10.32	9.27	32.94	46.78
Illinois	11.53	12.07	8.14	6.02	27.92	37.76
Wisconsin	8.92	13.23	8.16	5.87	25.53	36.18
Minnesota	6.09	13.39	8.42	3.78	24.43	31.68
Iowa	10.57	16.72	8.88	6.38	32.14	42.53
Missouri	12.67	13.34	9.29	6.42	30.74	41.72
Nebraska	8.76	12.56	6.25	5.09	24.93	32.62
Mean for twenty States	11.53	12.75	10.55	8.19	28.85	43.02

IS THE RAINFALL INCREASING?

Certain changes have been taking place in Kansas within the past twenty years which undoubtedly have a tendency to increase the amount of rain. Among these changes, all of which result from the settlement of the State, the following may be mentioned :

First, the plowing of the soil, which is thus enabled to retain a greater proportion of the rain which falls upon it ; second, the increase of timber, due to the partial checking of the prairie fires and to the direct influence of settlers in planting trees ; and third, the gradual supplanting of the short buffalo grass by the longer and heavier grasses which now prevail in eastern Kansas. It is, however, impossible to present positive proof of the permanent increase of our rainfall, on account of the limited period of observation. The records of at least fifty years would be required to afford a scientific basis for determining this question.

UNIFORM DISTRIBUTION OF RAIN.

Another marked effect of the settlement of a new country would naturally be to secure a more regular distribution of the rain. On this point also, the records are insufficient for positive confirmation. It is, however, the unanimous testimony of the oldest residents of Kansas, that the rainfall is more equally distributed now than ten years ago, coming at shorter intervals and more gently, and that single storms or showers extend over more hours than formerly. My own records at Lawrence show that during the growing season, from March 1st to October 1st, the longest intervals without rain was in the first year of observation, 1868. The rainless intervals for each of the five years were as follow : 1868, seventeen days; 1869, ten days; 1870, eleven days; 1871, eight days; 1872, ten days. From these facts it appears that in neither of the five years was there any approach to a drouth. The number of days on which either rain or snow fell in each year, was as follows : 1868, 77; 1869, 105; 1870, 100; 1871, 120; 1872, 116. This gives an average of 103.6 rainy or snowy days for each year. The average number of such days at Marietta, Ohio, for a period of thirty-two years (1827-1859), was 85.6, and at Brunswick, Maine, for a period of fifty-two years (1807-1859), the corresponding number was ninety-four. (Smithsonian Contributions to Knowledge, vol. xvi.)

SNOW.

Snow is recorded to have fallen as late as April 21st (in 1871), and as early as October 19th (in 1869), but not enough in the former case to whiten the ground. A single fall of snow rarely exceeds

six inches in depth and rarely remains on the ground a week at a time. The heaviest fall of snow was nine inches, which occurred on December 6th, 1868. The following table shows the depth of snow for each month of the five years :

Table VIII.—Depth of Snow in inches for each month, at Lawrence, Kansas, from January 1, 1868, to January 1, 1873.

Year.	Jan.	Feb.	March.	April.	Oct.	Nov.	Dec.	Yearly Amount.
1868	5.00	0.50	0.00	0.00	0.00	6.00	16.00	27.50
1869	4.00	5.25	1.00	1.00	1.25	0.00	5.50	18.00
1870	3.00	0.00	0.00	0.00	0.00	0.00	6.50	9.50
1871	11.00	4.00	4.00	0.00	0.00	5.00	5.75	29.75
1872	1.00	7.75	3.50	0.00	0.00	0.00	11.00	23.25
Mean.....	4.80	3.50	1.70	0.20	0.25	2.20	8.95	21.60

Another important element in climate is the

WIND.

The relative frequency of each of the eight directions of the wind is given in the following table, which embodies 5481 observations. The figures represent the number of times the wind blew from each direction for each year :

Table IX.—Relative Frequency of each Direction of the Wind at Lawrence, from January 1, 1868, to January 1st, 1873.

Year.	N.	S.	E.	W.	N. E.	S. E.	N.W.	S.W.	Calm.
1868	117	228	124	114	92	90	187	141	25
1869	121	243	68	102	95	87	198	126	55
1870	185	325	106	77	56	56	182	71	37
1871	113	225	77	80	72	116	176	193	43
1872	130	255	95	51	88	106	235	116	22
Sums ...	666	1276	470	424	403	455	958	647	182
Times in 1000....	121	233	86	77	74	83	175	118	118

It will be seen from this table that the south winds (including southeast, south, and southwest winds) outnumber the north winds (including northeast, north, and northwest winds) in the ratio of 434 to 370. At Marietta, Ohio, which is in nearly the same latitude as Lawrence, the south winds also prevail, while at Brunswick, Maine, on the contrary, the north winds outnumber the south winds in the ratio of 503 to 417. In regard to the

VELOCITY OF THE WIND,

Our observations extend over the brief period of six months, from July 1st to December 31st, 1872. During this time the anemometer placed on the north dome of the University building registered

64,828 miles as the entire distance traveled by the wind. This gives an average hourly velocity of nearly fifteen (14.68) miles. The greatest velocity recorded was sixty-five miles an hour from 9 A. M. to 3 P. M. on November 14th. For the sake of comparison it may be mentioned that the mean hourly velocity of the wind at Philadelphia is eleven miles; at Toronto, nine miles; at Plymouth, England, nine miles; at Liverpool, thirteen miles.

FACE OF THE SKY.

The following table gives the average cloudiness in hundredths for each month and year during the period of observation :

Table X.—Mean Cloudiness at Lawrence, Kansas, from January first, 1868, to January first, 1873.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	36.13	24.71	51.18	52.00	29.62	41.71	45.96	42.87	46.77	36.34	51.77	49.16	42.35
1869	43.97	51.20	52.81	51.00	46.01	56.74	53.33	45.49	45.44	25.38	62.89	56.56	49.23
1870	49.25	43.69	56.13	49.33	43.87	39.44	30.64	52.80	68.66	54.19	36.83	49.79	47.88
1871	64.00	49.88	52.06	47.11	45.70	46.33	49.79	39.14	34.67	36.77	57.44	45.27	47.37
1872	42.69	54.94	55.06	55.12	55.27	35.33	50.86	33.76	58.33	21.40	44.89	44.30	44.33
Mean..	47.21	44.88	53.45	50.91	44.09	43.91	46.11	42.87	46.77	34.82	50.76	49.02	46.23

It thus appears that on the average a little more than forty-six hundredths of the sky was covered with clouds during the five years of observation. This corroborates the assertion so often made that in Kansas there is a greater proportion of sunny weather than in the Eastern States. In the New England States the average cloudiness is fifty-three hundredths of the sky; in the Southern States forty-seven hundredths; and at Sacramento, California, only thirty-one hundredths; while throughout Great Britain the average reaches seventy hundredths. During our period of observation at Lawrence, the average number of clear days in a year was 157, counting as clear those days on which not more than one-third of the sky was covered with clouds; the average number of half clear days was 89, including under this designation those days on which between one-third and two-thirds of the sky was covered, and the average number of cloudy days was 120, when two-thirds or more were covered. The average number of entirely clear days was 35, and the number of entirely cloudy days was 36.

HUMIDITY OF THE AIR.

The amount of moisture contained in the atmosphere is another important element in climatology. Much has been said in reference to the dryness of the air in Kansas, and on account of this property many invalids have received permanent benefit from a residence in

this State. Our observations on this point are limited to the brief period of two complete years, during which time the average relative humidity was 66.4, complete saturation being represented by 100. By this is meant that upon the average the air contained two-thirds of the amount of moisture it was capable of containing. This percentage of moisture forms a very desirable mean between the very moist and the very dry, being alike favorable to the healthful condition of man, the domestic animals and the growing crops. The relative humidity at Philadelphia is 72, the air containing nearly three-fourths the amount of moisture required for saturation.

I have thus briefly touched upon the most important features of the climate of Kansas, as illustrated by my own observations, trusting that these results may lead to a more accurate knowledge of the subjects involved than is generally possessed by the citizens of Kansas and other States.

Respectfully yours,

FRANK H. SNOW,

Professor of Natural History and Meteorology in the University of Kansas.

GEOLOGY OF THE ARKANSAS.

BY B. F. MUDGE.

This paper is based on observations made in the Arkansas valley at various visits during the past five years, and particularly on a trip recently made as far west as Fort Aubrey, near the Kansas and Colorado line. We confine our remarks to that part between Hutchinson and Fort Aubrey, or that portion covered by the red sandstone of the Cretaceous period.

Observations made the past year confirm the statement in one of my papers read before a former meeting of this Association, viz.: that there is in Kansas no geological representation of the formations found in other countries, between the upper Carboniferous measures or Permian, and the Cretaceous. Careful search has been made for fossils of Jurassic and Triassic periods along the western borders of the Permian, and none have been found, while dicotyledonous leaves and other Cretaceous fossils have lately been procured nearer the line of the Permian than during our first collections.

The Arkansas valley, by its fossils, shows the same peculiarity.